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Study of Some Major Non-Biodegradable Solid Wastes Along Thane Creek of Mumbai

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Abstract Thane creek is one of the most important ecosystems around Mumbai, and the mangroves surrounding the ecosystem form the vital green lung for the residents. It is also an important feeding and breeding ground for fishes. In recent past man has misused this ecosystem by way of releasing sewage, dumping solid waste, etc. and has succeeded in chocking the ecosystem. The results of present investigation indicates that plastics carry bags, milk/oil bags, plastic bottles and foot wares are some of the major NBDSW materials responsible for solid waste pollution. On the basis of the findings, it is suggested that accumulation of plastics and synthetic rubber can be controlled by recycling and incineration, while accumulation of glass can be controlled only by recycling. The objective of the present work is to throw light on deteriorating condition of Thane creek, suggesting the need to prepare a well-planned waste management system.

Keywords Non-Biodegradable Solid Waste, Municipal Solid Waste, Plastics, Synthetic Rubber, Glass, Quantification, Environmental Hazard, Environmental Pollution, Thane Creek, Kalwa Bridge, Balkum, Saket, Akashganga, Mumbai

1. Introduction

The wetland of Thane Creek, located at Thane, Mumbai, India, has attracted much attention of environmental biologists over the last few decades, as this creek has been subjected to a lot of pollution from the Asia's biggest Thane–Belapur Industrial Complex located at the south of Mumbai harbor along the west coast of India. The creek area is one of the most important ecosystems around Mumbai and Thane, and the mangroves surrounding the ecosystem form the vital green lung for the residents. It is also an important feeding and breeding ground for fishes. Locals have been living in harmony amidst this ecosystem for ages, but in recent past man has misused this ecosystem by way of releasing sewage, dumping solid waste, etc. and has succeeded in chocking the ecosystem. The creek is tidally influenced with the dominance of neretic waters and negligible fresh water flow except during the monsoon. The substratum of the creek in the midstream is made up of consolidated and unconsolidated boulders intermingled with lose rocks and rarely with sand and gravel. Extensive mudflats are formed along both the banks of the creek which are characterized by the growth of mangroves. This area is also highly bio productive and yields about 2 to 3 thousand metric tones of fish annually. However, recent rapid urbanization and industrialization with improper environmental planning has resulted in discharge of industrial and sewage effluents into the creek[1]. This area was developed by the state government essentially for the chemical industries towards the beginning of the sixties and at present about 25 large industries and about 300 medium and small scale units using hazardous chemicals is located out of the total of 2000 units located in this zone. The industrial area utilizes about 45000 m^3/day of fresh water. The effluent discharge, treated and untreated amounts to 28750 m^3/day i.e. 64% of the total industrial effluents generated in Thane Creek area. Except for a few major industries, the medium and the small scale industries discharge their treated or untreated effluents through the unlined surface drains into the Thane Creek. In addition to this, domestic sewage discharges from suburbs of Mumbai City meet the Thane Creek from the west side. Also atmospheric fallout from the chimneys and stacks and vehicle exhausts estimated to be 22000 t/day over the city, reach the creek after washout. The problem is furthered by unrestricted dumping of solid waste, construction debris and other waste. Because of all this, the quality of sediment along the creek area is greatly affected[2, 3]. This has created health hazards not only for local population but also resulted in disturbances of mangrove ecosystem. The pollution control cell of Thane Municipal Corporation (TMC) has been conducting extensive survey and sampling of Thane Creek water and soil[4, 5]. Apart from that extensive research work[1-3, 6-10] has been carried out to address the pollution issues along Thane Creek; however very less attention has been given towards problem due to non-biodegradable solid waste (NBDSW)[11]. Therefore in the present investigation attempt was made to quantify three

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major NBDSW along the Thane Creek.

2. Materials and Method

2.1. Study Area

The study was carried out in a creek near Mumbai City, which is one of the most heavily populated and industrialized cities of India. The creek, known as 'Thane Creek' separates the Island City of Mumbai in the west from the mainland in the east and houses industrial areas at a distance of about 25 Km north–east of Mumbai city. Thane Creek lies in the southern part of the Deccan belt of India between latitude 18°53' to 19°04' N longitude 72°48' to 72°53' E. It is a triangular mass of brackish water which widens out and opens to the Arabian Sea in the South. The creek is narrow at the Northern end, where it is fed partially by river Ulhas. The geographical location of Thane creek is shown in Figure 1. The creek could be considered as an estuary during south-west monsoon period when the land drainage and river run-offs are considerable. During this period salinity drops down to about 4‰. During the rest of the year the salinity is maintained in accordance with the ingress of seawater (maximum 38‰).

Figure 1. Map Showing Geographical Location of Thane Creek

2.2. Climate

The weather of Thane is typical coastal sultry and humid. Most parts of Thane lies in the plain at the sea level. The average rainfall of Thane records from 1500 mm to 2000 mm. The place experiences the onset of the monsoon in the month of June and experiences monsoon till the end of September. The average temperature recorded in Thane varies from 25 to 37 degrees.

2.3. Methodology

The solid waste accumulated along Balkum, Saket, Akashganga, Kalwa Bridge, and Chatrapati Shivaji Hospital sites of the Thane Creek (Figure 2), was separately cleared before the spring tide. The predominant solid wastes, viz. plastics, glass and synthetic rubber were collected, washed and weighed after drying (First sampling). The quantification studies were repeated after the spring tide to know their accumulation in one spring tide i.e. 15 days (Second sampling). The results are presented in kilograms per hectare. The present study was carried out from October 2010 to February 2011 to quantify the accumulated NBDSW materials at the above five different sampling stations along Thane Creek. The solid waste material was properly dumped in the garbage depots after the quantification studies were finished.

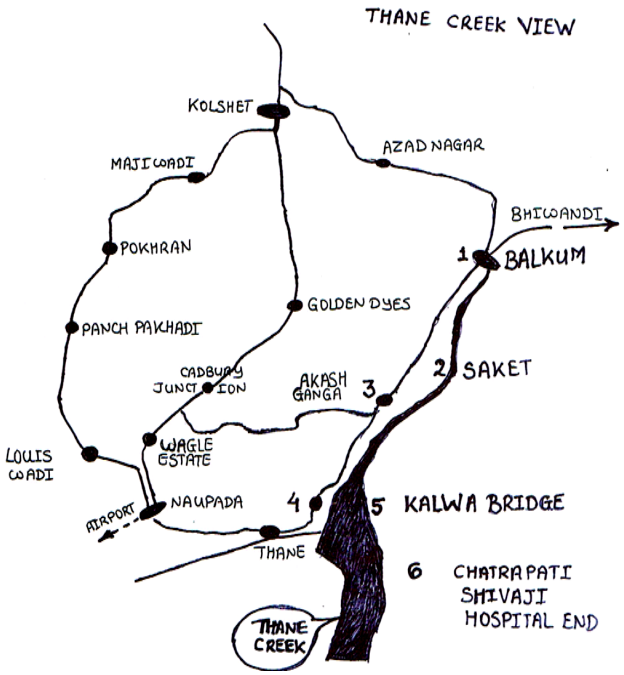


Figure 2. Sampling Locations along Thane Creek

3. Results and Discussion

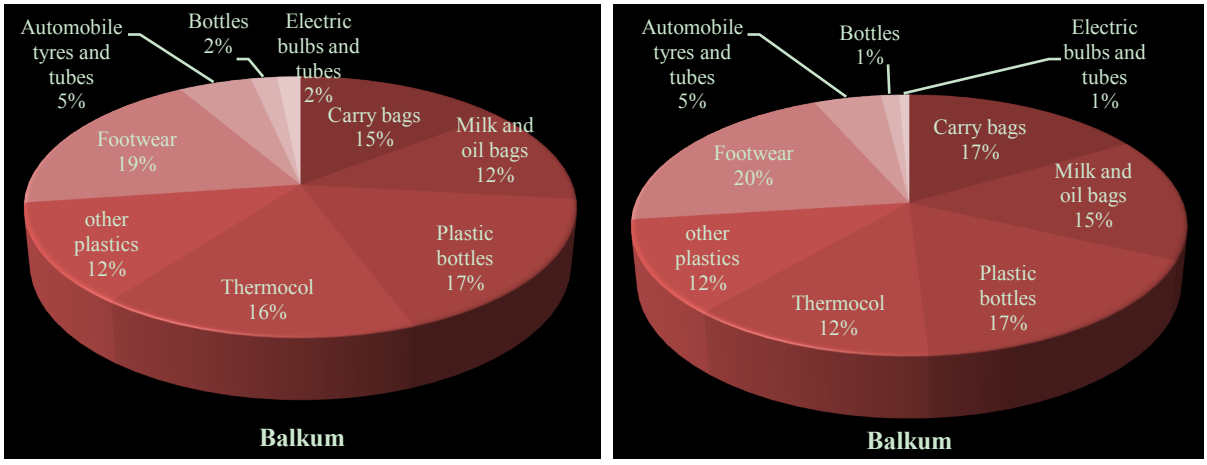
The present study shows enormous quantity of solid waste accumulation along the Thane Creek of Mumbai (Table 1). NBDSW materials enter the creek through different point sources. It is observed that residential zones, hospital as well as industrial belt near Balkum, Saket, Akashganga and Kalwa Bridge are the major sources of solid waste pollution. The domestic sewage channels often bring a lot of solid waste in the form of plastic bottles; carry bags, etc into the creek. The percentage contribution of different NBDSW materials at different sampling stations along the Thane Creek is represented in Figures 3-7.

The results of the present investigation indicate that at Balkum sampling station, contribution of plastic to the total NBDSW solid waste was 72% and 73%, contribution of synthetic rubber was 24% and 25%, while glass contributes to 4% and 2% in first and second sampling respectively. Among the plastic solid wastes, major contribution of 44% and 49% was due to milk/oil bags, plastic carry bags and

plastic bottles, while thermocol contributes to 16% and 12% in first and second sampling respectively. Similarly, among the synthetic rubber NBDSW materials, major contribution of 19% and 20% was due to foot wares, while automobile tyre/tubes contributes to only 5% each in the two samplings respectively.

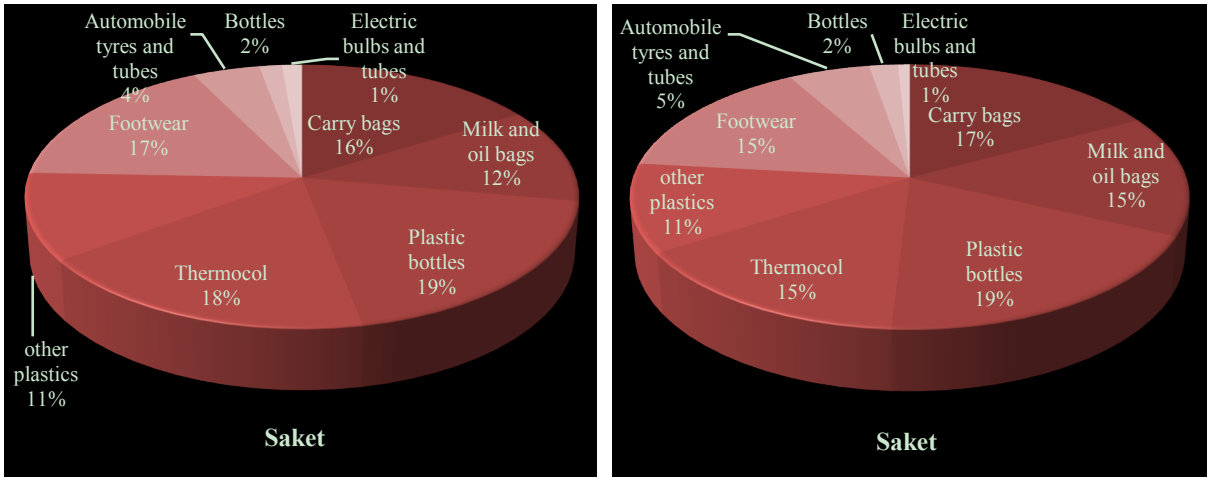
Table 1. Accumulation of NBDSW material along Thane Creek of Mumbai

Sampling stations → NBDSW		Balkum		Saket		Akashganga		Kalwa Bridge		Chatrapati Shivaji Hospital	
Category	Sub- category	Initial Collection (dry wt in kg/hectar	Collection After Spring Tide(dry wt in kg/hectar	Initial Collection(dry wt in kg/hectar	Collection After Spring Tide(dry wt in kg/hectar	Initial Collection(dry wt in kg/hectar)	Collection After Spring Tide(dry wt in kg/hectar)	Initial Collection(dry wt in kg/hectar	Collection After Spring Tide(dry wt in kg/hectar)	Initial Collection(dry wt in kg/hectar	Collection After Spring Tide(dry wt in kg/hectar)
Plastics	Carry bags	35.91	20.38	38.73	21.56	33.64	25.77	45.99	30.33	55.78	40.61
	Milk and oil bags	30.17	18.96	27.92	18.70	31.85	20.18	40.18	23.40	50.63	35.87
	Plastic bottles	43.26	21.01	45.78	23.77	46.30	23.91	51.62	28.39	58.99	31.24
	Thermocol (polystyren)	39.47	15.11	43.21	18.92	43.56	12.40	35.82	10.37	30.12	13.98
	Other plastics	30.80	14.29	25.47	13.61	28.51	15.73	35.90	19.55	40.26	24.69
Rubber	Footwear	46.27	25.18	40.83	19.03	43.98	20.89	48.66	22.01	45.59	21.72
	Automobile tyres and tubes	12.43	5.71	10.76	6.82	11.64	7.31	15.68	9.13	8.31	2.10
Glass	Bottles	4.49	1.51	3.63	2.40	6.10	2.99	7.97	3.08	20.83	12.53
	Electric bulbs and tubes	3.96	0.87	3.21	0.99	4.11	1.20	2.81	0.74	10.60	3.15



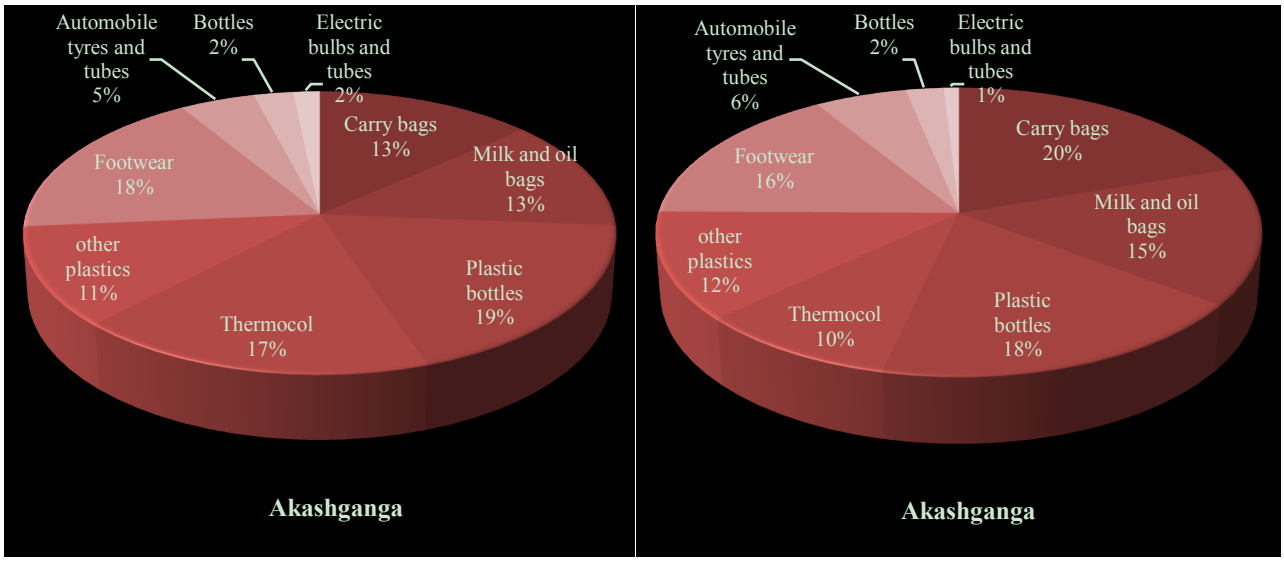
Initial Collection **Final Collection**

Figure 3. Quantification of NBDSW Collected along Balkum Sampling Station of Thane Creek



Initial Collection **Final Collection**

Figure 4. Quantification of NBDSW Collected along Saket Sampling Station of Thane Creek



Initial Collection **Final Collection**

Figure 5. Quantification of NBDSW Collected along Akashganga Sampling Station of Thane Creek

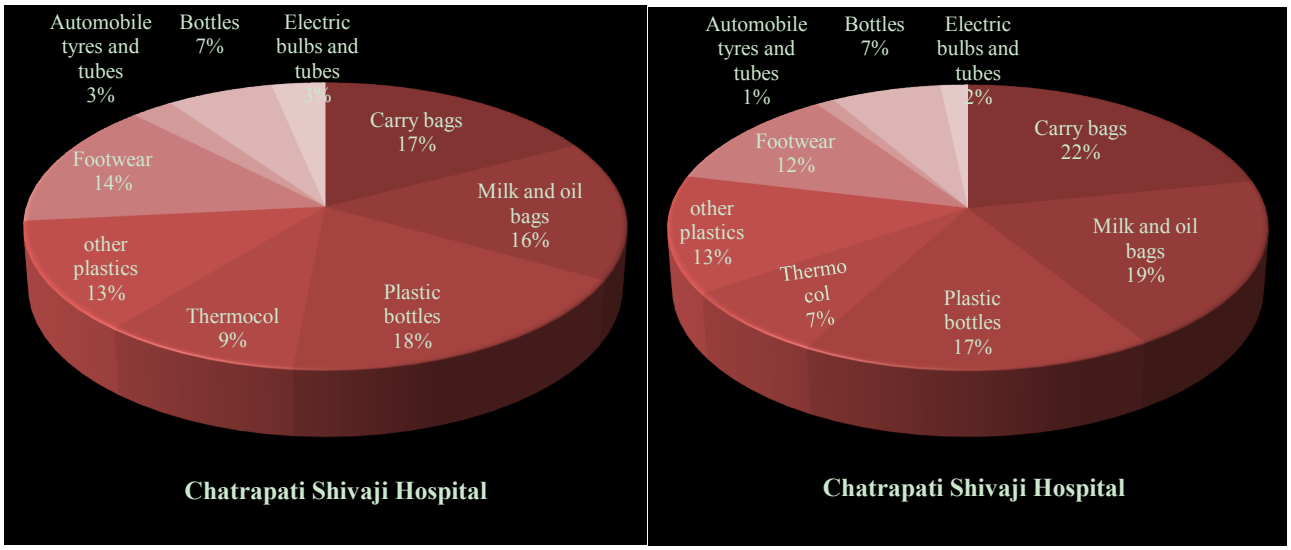
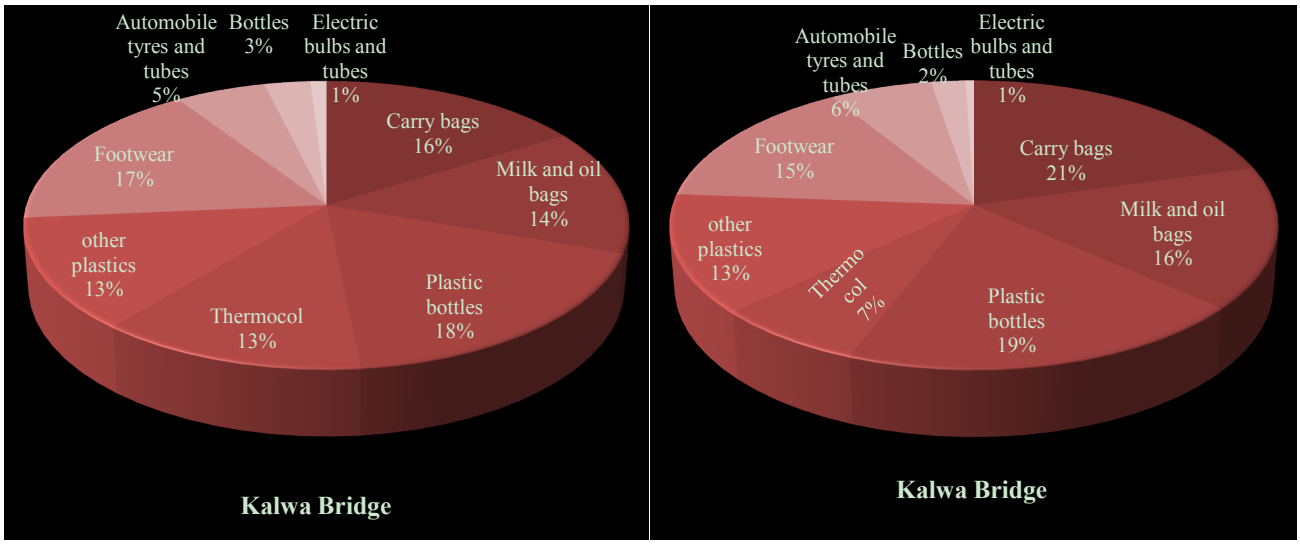


Figure 6. Quantification of NBDSW Collected along Chatrapati Shivaji Hospital Sampling Station of Thane Creek



Initial Collection **Final Collection**

Figure 7. Quantification of NBDSW Collected along Kalwa Bridge Sampling Station of Thane Creek

At Saket sampling station, it was observed that contribution of plastic to the total NBDSW solid waste was 76% and 77%, contribution of synthetic rubber was 21% and 20%, while glass contributes to 3% each in first and second sampling respectively. Among the plastic solid wastes, major contribution of 47% and 51% was due to milk/oil bags, plastic carry bags and plastic bottles, while contribution of thermocol was found to be 18% and 15% in first and second sampling respectively. Similarly in case of synthetic rubber NBDSW materials, contribution of footware to the total solid waste pollution was 17% and 15% which was the major contribution as compared to that of automobile tyre/tubes which contribute to only 4% and 5% respectively in the two samplings.

At Akashganga sampling station, the contribution of plastic solid waste to the total NBDSW materials was 73% and 75%, contribution of synthetic rubber was 23% and 22%, while glass contributes to 4% and 3% respectively in first and second samplings. Among the plastic solid waste, milk oil bags, plastic carry bags and plastic bottles contributes to the major extent of 45% and 53%, while contribution of thermocol was found to be 17% and 10% in first and second sampling respectively. Similarly in case of synthetic rubber NBDSW materials, contribution of foot wares to the total solid waste pollution was 18% and 16%, while automobile tyre/tubes contribute to only 5% and 6% in the two samplings respectively.

The contribution of plastic, synthetic rubber and glass NBDSW materials was found to be 74% and 76%, 22% and 21%, 4% and 3% respectively in first and second sampling performed at Kalwa Bridge sampling station. Among the plastic solid wastes, major contribution of 48% and 56% was due to milk/oil bags, plastic carry bags and plastic bottles, while thermocol contributes to 13% and 7% only in first and second sampling respectively. Similarly, among the synthetic rubber NBDSW materials, major contribution of 17% and 15% was due to foot wares, while automobile tyre tubes contributes to only 5% and 6% in the two samplings respectively.

The study of NBDSW materials collected near Chatrapati Shivaji Hospital indicates that plastic contribute to 73% and 78%, contribution of synthetic rubber was 17% and 13%, while glass contributes to 10% and 9% in first and second samplings respectively. Among the plastic NBDSW materials collected, the major contribution of 51% and 58% was due to plastic carry bags, milk/oil bags and plastic bottles, while thermocol contributes to only 9% and 7% in first and second samplings respectively. In case of synthetic rubber solid wastes, the major contribution of 14% and 12% was due to foot wares, while automobile tyres/tubes contribute to only 3% and 1% respectively in the two samplings.

It was observed that plastic balls and toys were some of the other plastic NBDSW materials most commonly collected at the above six different sampling stations along the Thane Creek. Tidal as well as wind action carry most of the solid waste which gets accumulated in the creek. In last many years, there has been extensive growth of residential area and industrial belt along the Thane creek. Some of the plastic bags and thermocol (polystyrene) from these residential and industrial areas also find their way into the creek.

The overall result indicates that plastics carry bags, milk oil bags, plastic bottles and foot wares are some of the major NBDSW materials responsible for solid waste pollution along the Thane Creek. The effects of NBDSW accumulation on the mangrove ecosystem of the creek as observed during the study have been summarized below.

NBDSW accumulated in the mangrove have changed the physico-chemical environment of the sediments by restricting the entry of sunlight and air. This has affected the nutrient recycling process of the entire mangrove ecosystem.

Solid wastes spread on the mangrove area prevent the development of seedlings from propagules.

Solid waste accumulation has affected the benthic fauna, the most important component of detritus food chain in the mangrove swamps.

Accumulation of solid waste destroyed the aesthetic beauty of the creek. The continuous process of accumulation of these materials has widened and strengthens the mudflats, which results in the narrowing of the channels.

Due to their varied sizes and colours, plastics and thermocol are wrongly taken as food by fishes, birds and crabs. This can prove to be fatal to these organisms. Such examples are frequently observed and also documented in urban environment[4, 5, 12-16]. It has created the severe threats to the existing mangrove plants and also has affected the regeneration process of the mangrove ecosystem.

Processing and Disposal of NBDSW materials: Considering the tremendous discharge of NBDSW materials in Thane Creek of Mumbai, it is of great importance to process and finally dispose of the accumulated solid waste in a safe manner. According to AIT[17], final disposal in most of the economically developing countries is usually a matter of transporting the collected waste to the nearest available open space and discharging them. Composting is the second preferred method for processing of solid waste, mainly due to the high percentage of organic material in the waste composition. In many islands of Maldives organic wastes are composted at home backyards and non-biodegradable waste (such as plastics) is dumped near the beach or buried in a few islands[18]. Burning of solid waste at designated areas is also widely practice. Waste burning is practiced to reduce its volume and minimize the attraction of animals and vermin. In addition to above, recycling of solid waste can also be carried out by hiring workers to conduct door-to-door collection of segregated recyclables[19]. Recycling is widely practiced by the informal sector "waste pickers" or by the solid waste management staff themselves for extra income. Collection of recyclable waste is done in several steps such as households (door to door collection), transfer stations and even in the disposal sites. Recovered and recyclable products then enter a chain of dealers, or processing before they are finally sold to manufacturing enterprises.

Recommendations: Considering the tremendous discharge of NBDSW materials in Thane Creek of Mumbai, it is of

great importance to process and finally dispose of the accumulated solid waste in a safe manner. Among the different NBDSW materials collected in the Thane Creek, plastics and synthetic rubber accumulation can be avoided by recycling and incineration, while glass can only be recycled. The adoption and transfer of the NBDSW management technologies from the developed countries without adapting them to the local or regional perspective would be fallacious on the part of the developing countries like India. Therefore, the technical aspects for a sustainable NBDSW management would have to take into account the following points for planning and implementation of strategies.

(1) Provision of facilities for primary collection of waste from curbside/community bins and adequate storage facilities in the urban areas based on the population density.

(2) Transportation of waste from the community storage facilities at regular intervals and improvement in the waste collection fleet.

(3) Transfer stations (at optimal distances from residential areas) should be constructed wherever necessary with provision for weighbridges.

(4) There must be a separate system for hospitals, health care establishments and industries to prevent the infectious and hazardous non-biodegradable solid wastes from entering the municipal waste stream.

Sustainable NBDSW management would also call for the strengthening of the management sector which has to go hand in hand with the above technical planning. An executable master plan and implementation plans for NBDSW management at the provincial level or the state level in accordance with the strategy for national environmental quality would help the management. The application of polluter pays principle to all waste generators, especially in urban areas including governmental and non-governmental agencies, private sectors and commercial enterprises; application of the 3R (Reduce-Recycle-Reuse) concepts, product stewardship, cleaner production and specification in the selection of packaging materials to the manufacturers is highly recommended. In addition to these there should be continuous monitoring and record keeping of non-biodegradable solid waste aspects with the development of a systematic information system that can be comparable, utilizable and updated; appointment of responsible governmental agencies that can regulate and supervise non-biodegradable solid waste management activities of both local government and private operators so as to reduce the environmental impacts. It is also important to provide organizational support by encouraging the involvement of private sector operators, NGOs and Community Based Organizations (CBOs); and finally the informal sector needs to be formalized.

4. Conclusions

The Thane creek of Mumbai is one of the most polluted creeks of India. NBDSW pollution is the one type of pollution that has been highlighted in the present paper. Since the collection and removal of solid wastes from mangrove areas is practically impossible, one of the alternatives is to prevent the NBDSW from entering the creek. This process should be immediately started through awareness programs and educating the people from various walks of life. Relocating the solid waste dumping yards away from the creek will also help solve the problem to a greater extent. For this, a clear-cut planning is required from the government agencies functioning at various levels to regulate the disposal of NBDSW material, before it is too late.

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